## Crew resource management in the Intensive Care Unit

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## SUMMARY

Errors occur in the Intensive Care Unit (ICU), some with severe consequences for patients. There is increasing evidence that these errors can be counteracted by training healthcare providers in the use of non-technical skills, such as communication, leadership and teamwork. Crew resource management (CRM) is a team training that aims to help participants develop their non-technical skills. However, the results regarding the effectiveness of CRM in the present literature are inconclusive due to design and methodological limitations. Furthermore, the costs and implementation of CRM training have not been considered up to date.

Therefore the main objective of this thesis was to study the implementation and evaluate the effectiveness and cost-effectiveness of a classroom based CRM training in the Intensive Care Unit. The following research aims with subsequent research questions were formulated:

1. Develop a sound study design with according instruments to evaluate CRM;
2. Study the implementation of CRM;
3. Assess the effects, costs and cost-effectiveness of CRM.

**Develop a sound study design with according instruments to evaluate CRM**

The study design (Chapter 2) was developed to assess the effects of CRM in the ICU, as well as to describe the process that explain such effects. Unique features relative to previous CRM evaluations are the follow up measurement of one year, the assessment of behavioural change with observations, and the use of matched control units. The framework of Kirkpatrick was employed to distinguish different levels of effect, notably reaction, attitude, behaviour and organization.

Two instruments had to be developed and validated to assess the constructs that were described in the study design. The first was a new observational method for assessing non-technical skills through quantifying explicit professional oral communication of healthcare professionals, called EPOC (Chapter 3). The results show good inter-observer reliability for the EPOC in two highly different settings. These findings indicate that the observers have been well-trained and that the framework is comprehensive and clear. Furthermore, it means that the EPOC is solid for use in scientific research and can be applied to other settings as well.

The second newly developed instrument was the SafeTeam questionnaire (Chapter 4). The results demonstrate that this questionnaire has a high reliability and validity to measure, respectively the attitudes towards and behaviour regarding behaviours that optimise Situational Awareness (SA). Based on the hypothesis that a

positive attitude and more applied behaviours are associated with a better SA, this questionnaire can be used as a proxy to measure SA.

**Study the implementation of CRM**

The implementation of CRM faced several barriers and facilitators to follow up on the CRM initiatives developed during the training (Chapter 5). The findings show that support of the management for patient safety *before* the training is a positive determinant of the number of perceived facilitators *after* the training. A significant relationship was found between the perceived barriers and facilitators *after* CRM training and Taking action. The more barriers are perceived, the less action is taken; and the more facilitators are perceived, the more action is taken.

The analyses of the separate barriers and facilitators after CRM revealed that each healthcare level provides important determinants. The facilitators with the most impact are: Being convinced of the benefits of CRM (perception of the innovation), having everybody engaged with CRM (social context), and that CRM fits well with existing work processes (organizational context). Analogously, the most influential barrier is forgetting the content of the training (individual context).

In regard or the applied strategies to implement CRM (Chapter 6), all three ICUs that received CRM training successfully launched several initiatives, yet each using a different implementation strategy. Furthermore, all ICUs have taken several steps to sustain their approach for the foreseeable future. Despite the variety in strategies, three similarities can be seen between all three implementation processes that were crucial at the start of the implementation: 1) All units reported problems with communication during the orientation phase; 2) All ICUs allocated structural time for quality improvement; 3) All units had a clear vision regarding their goals and strategies concerning CRM. Additionally, all ICUs indicated that they used the plans of actions that were formulated during the CRM training as a starting point for their follow-up initiatives.

**Assess the effects, costs and cost-effectiveness of CRM**

The third aim was to evaluate the effectiveness (chapter 7) and cost-effectiveness of CRM (Chapter 8). The first reaction to the training was positive, however, three months after CRM participants attributed only a moderate change in their behaviour as a result of CRM. Attitudes towards tactics to optimise situational awareness were stable, despite a small and not significant increase in the intervention group. Self-reported behaviour regarding tactics to optimise situational awareness did improve as a result of CRM training. There was no change in explicit professional communication.

Patient outcomes such as length of stay and complications were not affected by the CRM training. Scores on the dimensions of the patient safety culture show an upward trend in both the intervention and control departments. The way people respond to errors – the error culture – changed in the ICUs that received CRM training. In this group, respondents perceived themselves and their colleagues as being more aware regarding errors and being more socially oriented on the occasions they occur. Furthermore, after the training, participants responded that they thought it was important to overcome errors in the future and, to a lesser extent, be less error-aversive. These changes reflect the core principle of CRM of recognising and preventing errors, and mitigating the consequences when errors do occur. Job satisfaction and affective commitment increased in the intervention group,

The costs and cost-effectiveness of a classroom based CRM training and its implementation in comparison with usual practice was evaluated. The results show that the costs are around 1000 Euros per staff member of the ICU attending the CRM training or on average 90 Euros per admitted patient when the costs are spread over one year. CRM training was not cost-effective in comparison with usual practice with regard to mortality, readmissions within 24 hours and length of stay.

**General interpretation**

Based on the results it can be concluded that classroom based CRM training is a way to initiate, stimulate and/or facilitate quality improvement in health care, by raising awareness of, and creating a shared perspective on, the threats and opportunities in the work processes. This results show that all three intervention ICUs developed and implemented their own locally-owned initiatives. The multitude and diversity in initiatives echoes the catalysing effect of CRM on new and existing quality initiatives.

While providing the basis, improvements at the sharp end require a further implementation of CRM initiatives that go beyond the two days of training and a year-long course of activities of the CRM change teams after the training. A clear vision on this multifaceted implementation process should form the base of the follow-up strategy Structural time should be made available for preparation and implementation. During the process of implementation it is important to acknowledge that there are factors that impede or facilitate this implementation of CRM and the following initiatives. A next step for units that already have received CRM training could be the formation of a network of trained units to horizontally share information and knowledge, which in turn might evolve into a CRM community.

The mixed findings found in this theses as well as in the literature can be explained by the nature of CRM training itself. CRM, especially as applied in the current thesis but also in general, has a focus on creating awareness and not specifically to change behaviour in a certain direction. Rather, it stimulates participants to think of their own initiatives, for themselves, their team and their organization.

This open bottom up-approach leads to a diverse range of follow-up initiatives varying from session to session and from ICU to ICU.This diversity has several implications. Firstly, the effect of CRM is difficult to capture with one general outcome. Secondly, it can be questioned whether general behavioural patterns are likely to change as a direct result of these focused interventions within the evaluation period of one year. Thirdly, even if all ICUs started with a similar intervention, the success of its implementation can still be influenced by other factors. These explanations of the mixed results of CRM training on behaviour and organization, should be taken into account when an evaluation is conducted.

**Implications**

The newly derived insights based on this thesis lead to the following implications when either considering to apply CRM (implication for practise) or to evaluate the effect of CRM (implications for research). The most important implication for practice is that CRM can help participants to recognize, address, and handle safety issues. The following aspects should be taken into account when implementing CRM: Be ready for CRM; Convince, involve, connect and repeat; Use the ideas that are developed during the CRM training; Calculate the costs.

Regarding the implications for research, this thesis substantiates the argument that CRM training focusses on latent, non-clinical, aspects and has to be viewed as a generic intervention that generates specific interventions. This is important when designing an evaluation of a CRM training, especially when the effect is measured in clinical outcomes. Therefore, it is suggested to consider which intervention or initiative is focussed on, when designing the evaluation.

**Limitations**

Although the present study was carefully designed and tried to learn from previous flaws in design and methods, some methodological considerations have to be mentioned. The number of ICUs that received CRM training is limited. The experimental condition of intervention and control was not randomized. Errors, incidents, or adverse events as a measure of patient outcomes were not assessed. Both newly developed measurement

instruments, the EPOC observation tool and the SafeTeam questionnaire, should be further validated by comparing the results with other assessments. And finally, when generalizing the results to other settings, It should be taken into account that CRM training is not always similar across studies.

**Conclusion**

All in all, it is promising to note that all three ICUs in the current thesis, despite their own barriers, visions, strategies, and an overload of measurements, developed multiple quality improvement initiatives and aim to continue doing so.